


FLIGHT READINESS STATEMENT
STS-99/ET-92
EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW

EXTERNAL TANK ET-92/STS-99, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT
PRE-FLIGHT REVIEW DATED SEPTEMBER 1, 1999, IS CONSIDERED READY TO
SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK
AND/OR OPEN ACTIONS.


J. L. LUSK/MP31


J. BULLMAN/ED10


for A. F. WHITAKER/ED30


for A. O. GOODSON/QS01


A. C. ADAMS/QS20


D. L. DUMBACHER/ED20


G. R. WALLACE/ED40


P. V. COUNTS/MP31, CHAIRMAN

REVIEW ACTION ITEM			
CONTROL NO.	DATE ASSIGNED	ASSIGNEE(S)	DUE DATE
99-ET/SRB-001	6-28-99	ET, USA-INTEGRATION	7-2-99
ACTION:			
<p>CONFIRM ALL ET FOAM AREAS THAT ARE POTENTIAL DEBRIS SOURCES FOR THE SHUTTLE HAVE BEEN IDENTIFIED.</p> <p>IDENTIFY ANY POTENTIAL SOURCES THAT ARE NOT COVERED BY CERTIFIED VENTING PROCESSES.</p>			
RESOLUTION:			
<p>A) ALL ET FOAM AREAS THAT CAN IMPACT THE ORBITER HAVE BEEN IDENTIFIED BY BNA AND PROVIDED TO THE ET PROJECT.</p> <p>• THE BNA DEBRIS DATABASE, WHICH ANALYZES THE ENTIRE ET SURFACE, WAS USED TO DEFINE ALL SOURCE LOCATIONS THAT CAN IMPACT THE ORBITER FOR SEVERAL ASSUMED SIZES OF FOAM DEBRIS. (SEE RESULTS ON 7-PAGE ATTACHMENT.)</p> <p>• THE BNA DEBRIS TRAJECTORY PROGRAM WAS USED TO DEFINE THE SOURCE LOCATIONS WHICH IMPACT THE ORBITER FROM THE INTERTANK THRUST PANEL AREA. FOAM PARTICLE SIZE USED IN THE ANALYSIS WAS DOCUMENTED BY THE STS-96 SRB VIDEO CAMERA. (SEE ATTACHED 6/17/99 BRIEFING.)</p> <p>B) VENTING HAS BEEN ACCOMPLISHED FOR ALL CERTIFIED ET FOAM AREAS THAT ARE POTENTIAL DEBRIS SOURCES FOR THE SHUTTLE.</p>			
SUBMITTED BY:		APPROVAL:	
<i>Jack W. [Signature]</i> Assigned <i>Jack W. [Signature]</i> Assigned 7/1/99 Date		<i>David R. [Signature]</i> Space Shuttle Program 7/2/99 Date	

September 1, 1999

Space Shuttle
External Tank

STS-99/ET-92 Pre-Flight Review

ACTIONS:

- 1) Develop/Formulate Method of Reviewing
and Dispositioning Critical Processes
- 2) Side Action: Prepare Briefing For Don
McMurrage on How ET 92 was
violations were missed at the factory
- 3) Review 1st Time Around to see if that
was Reviewed/Presenter on sub

Agenda

Overview

Prior Mission Performance Summary

Current Mission/External Tank Highlights

ET-92 Mass Properties Status

Changes

Special Topic

- ET-92 Weld Specification Violations

SRM&QA Assessment

KSC Processing

Verification/Certification

Mission Unique Assessment

Readiness Statement

Appendices

- A: Minor Changes
- B: SRM&QA Assessment
- C: KSC Processing
- D: Level II Waivers/Level III Deviations

Lynn Servay

Rick Spring

Don Bolstad

Mike Bankester

Fred Lockhart

Lynn Servay

Overview

This review for STS-99/ET-92 includes:

- Items specific to mission STS-99
- First time changes, differences and “out-of-family” non-conformances not previously flown and/or reviewed

FRR Series

- | | |
|-------------------------------------|------------|
| • ET/SRB Mate Review | 06/28/1999 |
| • Pre-Flight Review | 09/01/1999 |
| • Space Shuttle Vehicle FRR | TBD |
| • Mission Management Team (L-2 Day) | TBD |

Prior Mission Performance Summary

STS-93/ET-99 Launch Attempts

System

07/20/99

(Scrub ~ T-8 sec due to high H2 concentration in Orbiter aft)

07/21/99

(Scrub due to inclement weather at launch site)

• OMRSD/LCC	No violations	No violations
• Instrumentation	No violations	No violations
• MPS	Nominal	Nominal
• ET Hazardous Gas	High H2 concentration in Orbiter	Nominal
• TPS	<ul style="list-style-type: none"> • 2 cracks in -Y Intertank thrust panel foam <ul style="list-style-type: none"> – No offset • Acceptable per NSTS 08303 	<ul style="list-style-type: none"> • 2 cracks in -Y Intertank thrust panel foam (Same as previous attempt) • Crack in -Y vertical strut foam • Frost on LH2 Tank siphon fitting • All acceptable per NSTS 08303

Prior Mission Performance Summary

STS-93/ET-99, 07/23/1999

System

Performance

- OMRSD/LCC

No violations

- Instrumentation

Accelerometer data consistent with previous mission

- Data consistent with design environments
- Evaluation of temp sensor data pending results of data reduction activities
- Strain gage pending temp sensor data reduction

- MPS

Early shutdown - LO2 depletion due to off-nominal engine performance

- ET Hazardous Gas

Nominal

- ET Disposal

Nominal

Prior Mission Performance Summary

STS-93/ET-99, 07/23/1999

System

Performance

- TPS
 - During third tanking, 6" long crack with ice formation noted on Longerons closeout
- Orbiter Tile Damage
 - Lower surface hits
 - Diameter > 1" = 42
 - Total = 161
 - Above average in number
- Post Flight Photo Review
 - Umbilical and crew photos from cockpit inconclusive
 - Details not discernible
 - SRB Cameras
 - Popcorning noted on thrust panels and adjacent stringer panels
 - Video review shows venting improves foam performance

Mission/External Tank Highlights

STS-99/ET-92, 10/10/1999 (UR)

Mission

Launch

- Window
- Pad
- Orbiter
- Orbital Inclination
- ET Photo Coverage

STS-99

10/10/1999 (UR)

2h 20m

A

Endeavour (OV-105)

57° - Insertion at 126 NM

- Crew photos from cockpit window
- Umbilical well cameras

Primary Payload

Landing

- Time
- Location

Shuttle Radar Topography Mission (SRTM)

10/18/1999 (UR)

TBD

KSC

External Tank

DD250 Acceptance

Shipped to Launch Site

ET-92

04/19/1999

04/23/1999

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ET-92 Mass Properties Status

Subject:

- ET-92 Weight Status

Status:

- The specification weight for ET-92 is 69,193 lbs
 - ET-92 was weighed 04/28/1999 @ KSC
 - Predicted 65,148 lbs
 - As-weighed 65,291 lbs
 - Delta +143 lbs
- ET-92 was weighed with compression platform scales

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Changes

Significant Process & Configuration Changes

- *Performance Enhancement (PE) High Q Loads Implementation* **Mike Quiggle**
- *Implementation of LH2 Common Proof Test*
- *LH2 Tank Changes to Accommodate SSME Block II Implementation*
- *LH2 Tank Siphon Screen Installation Hardware Changes*
- *LWT Intertank Thrust Panel Structural Change*
- Intertank Thrust Panel Foam Venting

Eugene Sweet

Class II Process Changes

Steve Copsey

Performance Enhancement High Q Loads Implementation

B02034

Change:

- Certified LWT for Performance Enhancement (PE) High Q loads and updated LH2 operational ullage pressure requirements

Background:

- High Q trajectories are part of an overall performance enhancement for ISS missions
- SLWT was designed for PE High Q trajectories
 - Three SLWTs flown with PE High Q trajectories
- PE induced environments were implemented for LWT
 - LWT algorithms were updated to reflect the PE loads

Performance Enhancement High Q Loads Implementation

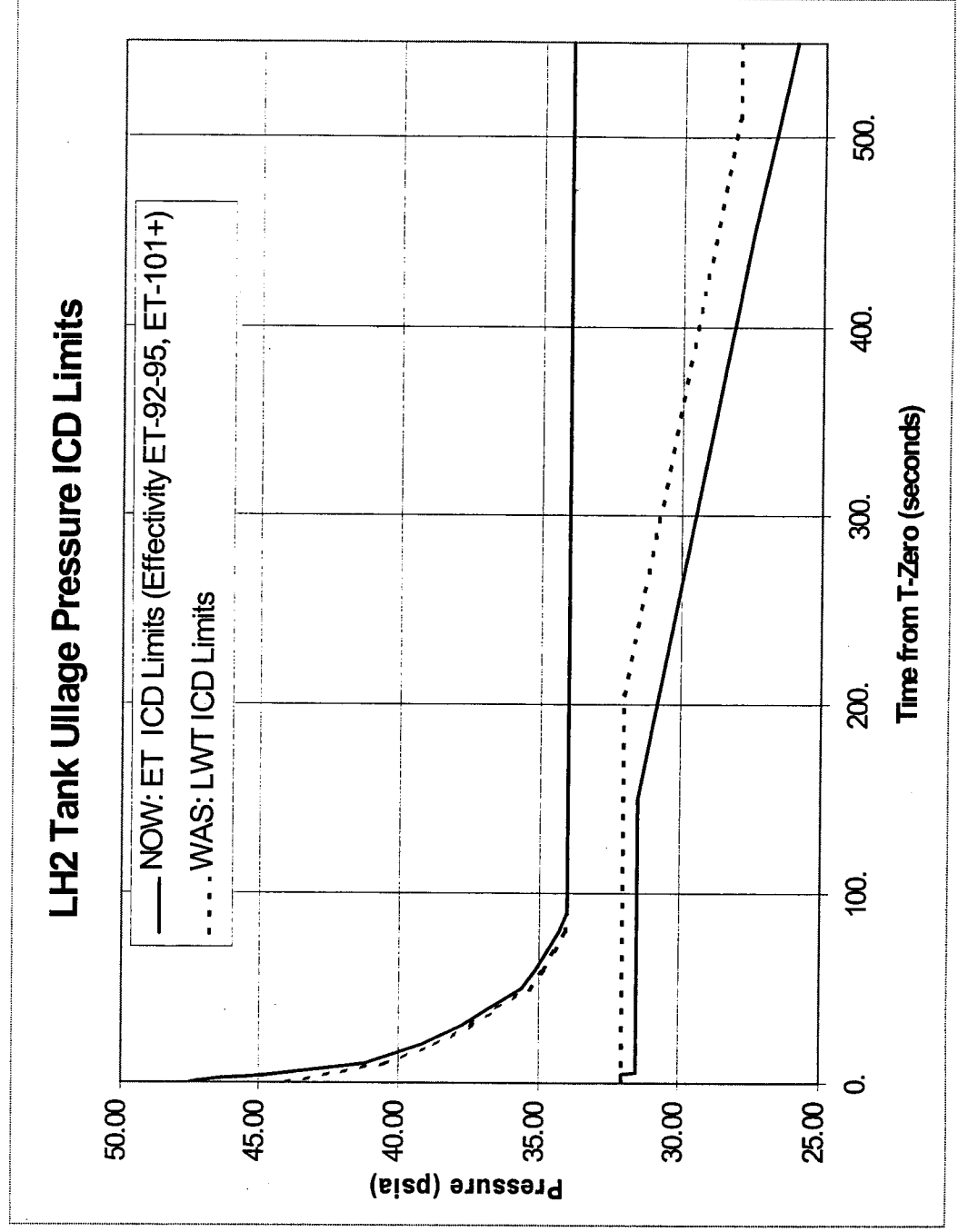
B02034

Discussion:

- Implementation of PE High Q loads required additional post proof inspections
 - Additional 1,791 inches of post proof weld x-ray on LH2 Tank circumferential welds
 - Additional 450 inches of post proof weld x-ray on LO2 Tank circumferential welds
- LH2 Proof Test enhanced to adequately proof more welds and mitigate post proof NDE requirements
 - Additional 1,791 inches of post proof weld x-ray inspection was reduced to 249 inches with modified proof test
- Changes in LH2 Proof Test led to implementation of a Common LH2 Proof Test for ET Program
 - Common set of post High Q loads supplied by Level II
 - Approved by PRCBD S052158BA on 8/21/98
 - Common LH2 ullage pressure ICD supplied by Level II
 - Approved by PRCBD S060604P on 8/25/98

Performance Enhancement High Q Loads Implementation

B02034



Performance Enhancement High Q Loads Implementation

B02034

Basis for Certification:

- Test and Inspection
 - Successful completion of LH2 Tank proof test and post proof inspection
 - LH2 Tank Common Proof Test implemented with increased loads
 - 249 inches of additional weld inspected
 - Successful completion LO2 Tank proof test and post proof inspection
 - 450 inches of additional weld inspected
- Analysis
 - Structural analysis shows overall critical factor of safety unchanged
 - Factor of Safety for critical circumferential welds (failure mode: ultimate tension)

<u>Weld ID</u>	<u>Required</u>	<u>Proof Test Demonstrated</u>	
		<u>Was</u>	<u>Now</u>
LH2 Tank HAF	1.31	1.49	1.19
LH2 Tank H7	1.32	1.82	1.28
		1.74	1.32

LH2 Tank Changes for SSME Block II Implementation

B02034

Change:

- Increased Pre-Launch ullage pressure requirement to accommodate future SSME Block II implementation
 - Revised LCC for LH2 Tank pre-launch ullage pressure and ICD for ullage pressure during flight

Background:

- Advanced high pressure fuel turbopump in the Block II SSME has increased preburner temperature spikes during engine start transient, causing reduced turbine blade life
 - PSIG action resulted in decision to modify the Block II Start Transient by increasing the LH2 inlet pressure at engine start command
 - Required modification of the ET pre-pressurization control bands and LH2 ullage pressure ICD
- Raised pre-pressurization control band will be used only on flights with three Block II SSMEs
 - Not required for STS-99/ET-92
 - First flight of three Block II SSMEs TBD (NET 2000)

LH2 Tank Changes for SSME Block II Implementation

B02034

Description:

- Revised LH2 Tank ullage pressure LCC limits during pre-pressurization
- The new Block II SSME limits will not be used for STS-99/ET-92

LH2 Tank Pressure Limit Change for Block II SSMEs

	Time (sec)	Maximum Pressure Limit		Minimum Pressure Limit	
		WAS (psia)	NOW (psia)	WAS (psia)	NOW (psia)
Pre-Launch (LCC):		44.1	48.9	40.9	46.1
Flight (ICD):	0	44.0	47.5	:	:
	1	43.7	47.3		
	2	43.3	46.4		
	3	43	45.4		
	4	42.6	44.8		
	10	40.5	41.25		
	:	:	:		

LH2 Tank Changes for SSME Block II Implementation

B02034

Description (continued):

- ET GH2 vent/relief valve requirements revised for higher pre-press level
 - No design change required
 - Reseat Pressure
 - **Was:** 34.0 psig minimum
 - **Now:** 34.25 psig minimum
 - Acceptance test instrumentation and requirements revised

LH2 Tank Changes for SSME Block II Implementation

B02034

Basis for Certification:

- Test
 - No change to critical test demonstrated LH2 Tank factor of safety
 - Raised LH2 Tank pre-press band was demonstrated on STS-91 Tanking Test
 - Narrow band with 0.5 second GHe bursts was demonstrated
 - Pre-press level demonstrated was 0.3 psi lower than planned for use with three Block II SSMEs
 - Changes to GH2 Vent/Relief Valve acceptance not implemented on STS-91/ET-96
- Analysis
 - Stress analysis shows no change in critical factor of safety
 - Propulsion analysis shows LH2 Tank ullage pressure will be within LCC limits during pre-press

LH2 Tank Siphon Screen Installation Hardware Changes

B02038

Change:

- Modified hardware for the LH2 Tank siphon screen installation
 - Replaced gang nut channels with new standard dome gang nut channels
 - Replaced cadmium plated bolts/screws with passivated A286 bolts/screws

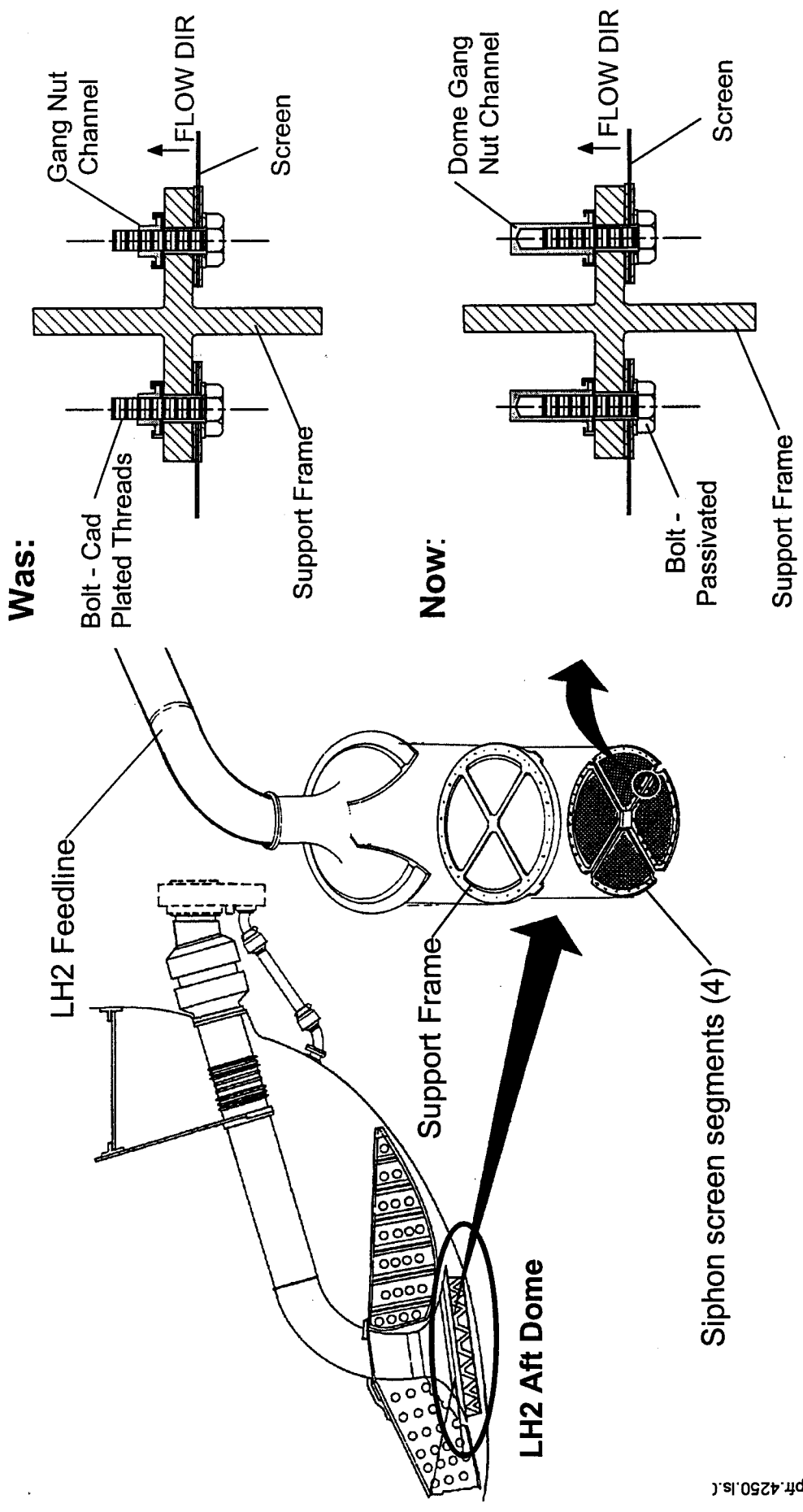
Background:

- Inspection of ET-99 LH2 internal siphon feedline screen installation identified particles (greater than 400 microns) on downstream side of screens
- Review conducted of process flow for LH2 aft dome for potential source of contamination
 - Contamination found to be created during installation of LH2 screens onto the gang nut channel on the siphon support frame
- Particles collected and submitted for laboratory analysis
 - Material collected determined to be from screen bolt/nutplate installation and removal process

LH2 Tank Siphon Screen Installation Hardware Changes

B02038

Description:



LH2 Tank Siphon Screen Installation Hardware Changes

B02038

Basis for Certification:

- Similarity
 - Addition of passivated bolts/dome nuts does not affect the capability or function of the siphon screen assembly
 - Passivated bolts eliminate a potential source of contamination
 - Dome nuts on siphon screen assembly capture potential contamination from the bolts on the downstream side of the siphon screen

LWT Intertank Thrust Panel Structural Change

B02039

Change:

- LWT Intertank thrust panel structure modified to add stiffeners

Background:

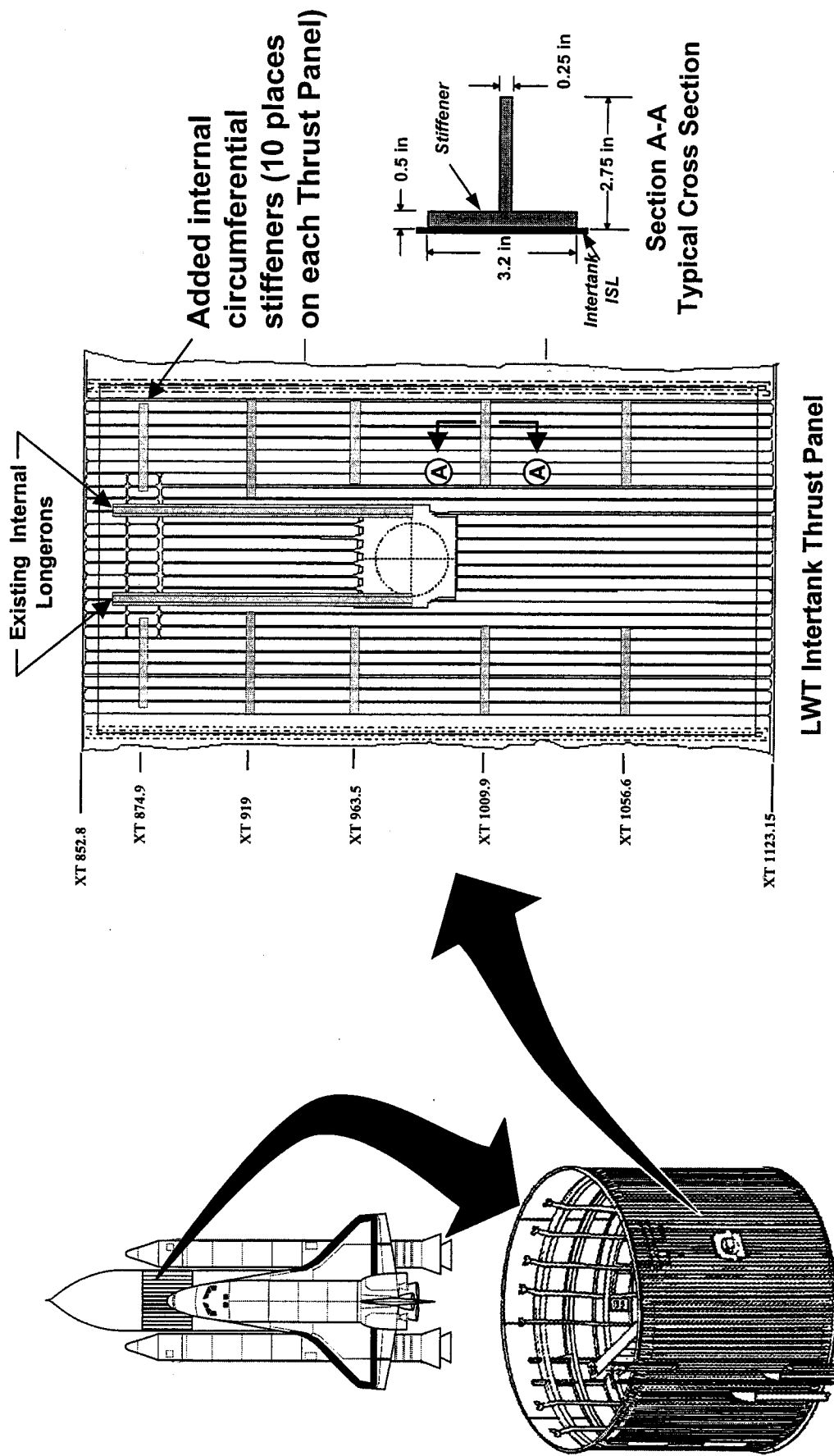
- Intertank thrust panel flexure was initially believed to be a contributor to thrust panel foam loss
 - Internal stiffeners were identified as a design change to decrease thrust panel flexure

Description:

- Ten circumferential Al 7075 stiffeners added to each Intertank thrust panel
 - Located on inside of Intertank
 - Installed with Hi-Lok fasteners
 - Stiffener material same as used for Station 985 outer chord extrusions

LWT Intertank Thrust Panel Structural Change

B02039



Changes

Significant Process & Configuration Changes

- Performance Enhancement (PE) High Q Loads Implementation
 - Implementation of LH2 Common Proof Test
- LH2 Tank Changes to Accommodate SSME Block II Implementation
- LH2 Tank Siphon Screen Installation Hardware Changes
- LWT Intertank Thrust Panel Structural Change
- *Intertank Thrust Panel Foam Venting*

Mike Quiggle

Eugene Sweet

Class II Process Changes

Steve Copsey

Intertank Thrust Panel Foam Venting

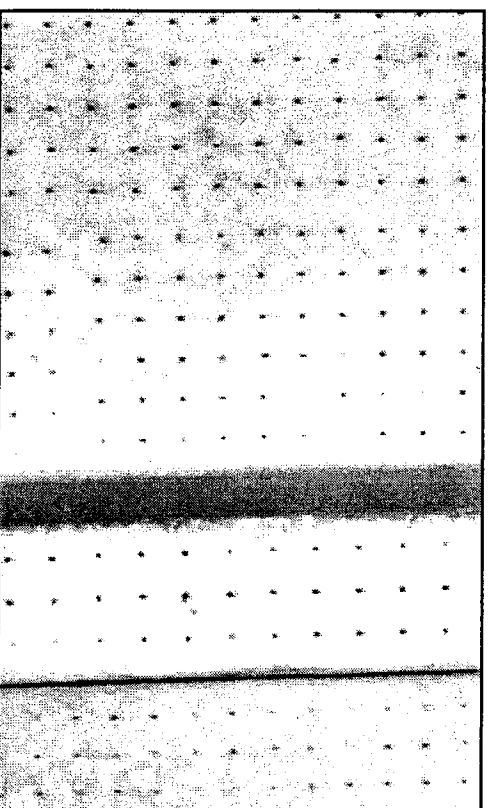
FEC KEI-0053

Change:

- Vent portions of the Intertank thrust panel foam
 - 0.032" diameter pin holes will be spaced 0.30" apart

Background:

- Post flight inspection of STS-87 revealed out-of-family damage to the Orbiter tiles caused by foam loss from the ET Intertank thrust panel
- A rigorous test program has demonstrated the potential for vented foam to reduce popcorn-type debris
- Vented foam configuration has been certified by test and analysis to do no harm
- Venting of Intertank foam implemented on STS-96/ET-100 and STS-93/ET-99
- Review of SRB video following May 27, 1999 flight of STS-96/ET-100 confirmed performance enhancement realized through foam venting
- Based upon STS-96/ET-100 data and additional analysis, areas of Intertank thrust panel vented on STS-93/ET-99 was increased
 - Review of STS-93/ET-99 SRB video confirmed performance enhancement through venting



Typical Vented Foam Configuration

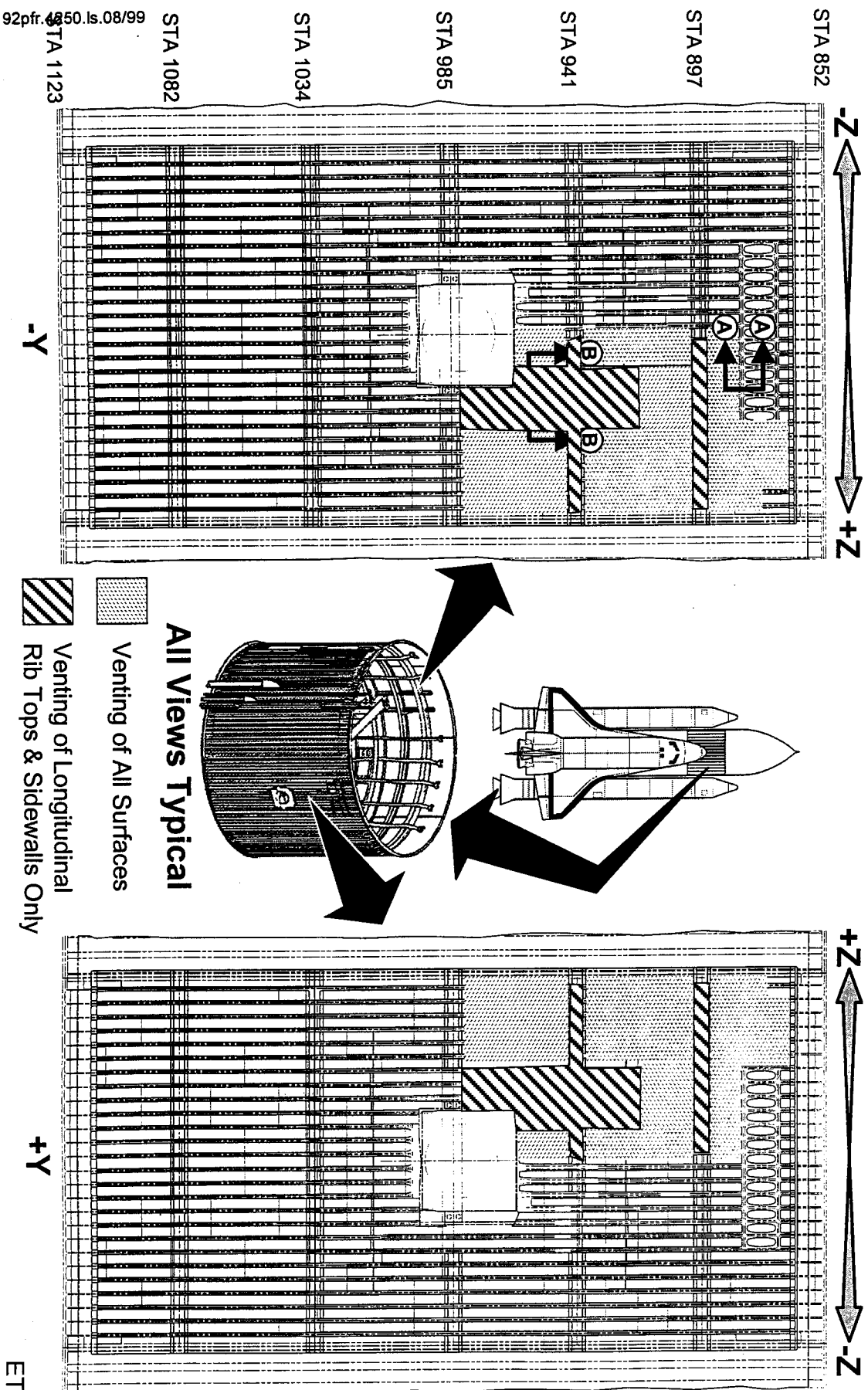
Intertank Thrust Panel Foam Venting

FEC KEET-0053

Description:

- Foam selected for venting on STS-99/ET-92 based upon the following criteria:
 - Foam configuration demonstrated by test to do no harm
 - Longitudinal ribs and valleys with foam thickness between 0.2" and 0.9"
 - Foam located within Intertank thrust panel zone identified by Integration/BNA as having the potential to generate debris that can contact/damage the Orbiter lower surface
 - Areas that could result in foam/vent tool damage during the venting process (i.e., foam areas with fasteners or other protuberances)
 - Foam not located in a cryogenic region of the thrust panel
- Areas fulfilling these criteria cover the majority of the forward +Z quadrant of each Intertank thrust panel

Intertank Thrust Panel Foam Venting FEC KET-0053

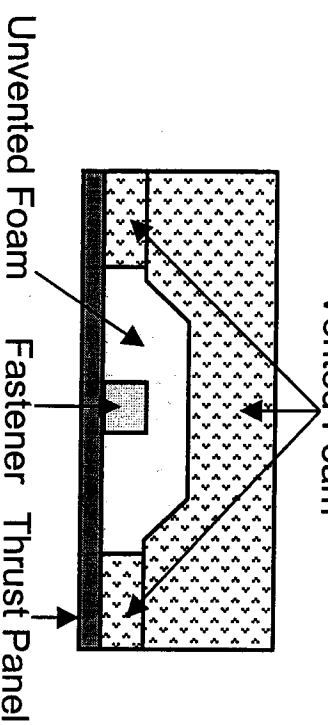


Intertank Thrust Panel Foam Venting FEC KET-0053

Description (continued):

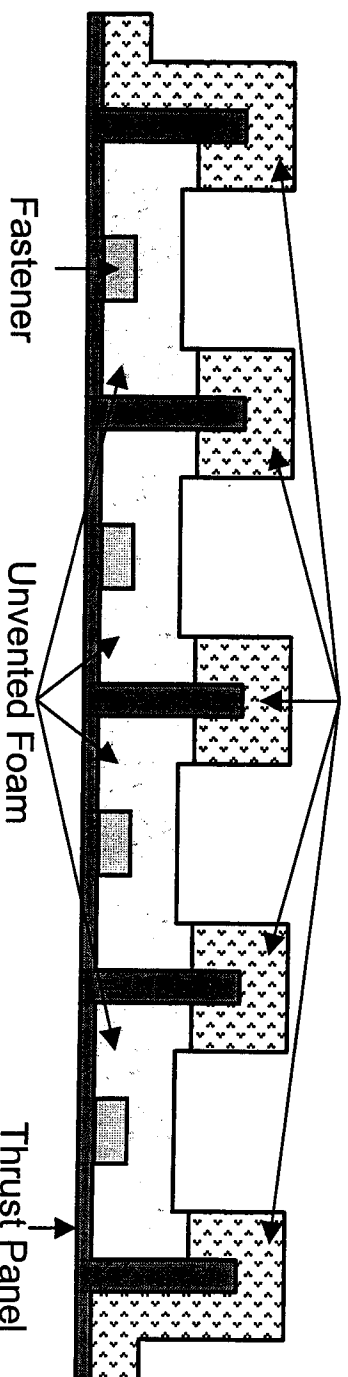
Section A-A (Typical Fastener Ramp)

- Rib valleys not vented at these locations due to underlying fasteners



Section B-B (Typical 1.05" Thick Valleys)

- Rib valleys not vented at these locations due to underlying fasteners



Intertank Thrust Panel Foam Venting

FEC KEET-0053

Basis for Certification:

- Test
 - Tests performed in different test beds following various environmental conditioning
 - Results from all performance testing show that vented foam performs as well as or better than the non-vented foam configuration and measurably reduces foam loss
- Similarity
 - Vented foam configuration similar to configuration flown on STS-96/ET-100 and STS-93/ET-99

Certification Test	No. of Tests	Humidity	Salt Fog	Vented
Vented Foam Certification Testing				
Mechanical Properties/Acceptance Testing				
Density	200			X
Bond Tension	540	X	X	X
Flatwise Tension	540	X	X	X
Lap Shear	360	X		X
Plug Pulls	144		X	X
Flexure (Ribbed panels)	24	X		X
Thermal Properties				
Thermal Conductivity	24	X	X	X
Flight Verification				
Hot Gas - Flat Panels, Machined foam	20	X	X	X
Hot Gas - Rib Panels, Machined foam	63	X	X	X
Thermal/Vacuum, Flat Panels, Machined foam	40	X	X	X
Thermal/Vacuum, Single Rib Panels, Machined foam	14			X
Thermal/Vacuum, Rib Panels, Machined foam	24	X	X	X
Wind Tunnel (AEDC), Machined foam	4			X
Vibro/Acoustic Test (DOE C Addendum Testing)	6	X		X
Process Verification/Acceptance				
Full-Scale Process Pathfinder (GVTA)	1			X

Changes

Significant Process & Configuration Changes

- Performance Enhancement (PE) High Q Loads Implementation
 - Implementation of LH2 Common Proof Test
- LH2 Tank Changes to Accommodate SSME Block II Implementation
- LH2 Tank Siphon Screen Installation Hardware Changes
- LWT Intertank Thrust Panel Structural Change
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Mike Quiggle

Eugene Sweet

Class II Process Changes

Steve Copsey

Class II Process Changes

H35809-967

Change Description:

- Changed ablator process from sprayed ablator to molded ablator on the +Y Vertical Strut Cable Tray splice cover at LH2 Dog Leg Cable Tray

Reason for Change:

- Change to molded ablator process allows testing on witness panel and eliminates repair of test area
 - Repair covered ~ 50% of the component

Basis for Certification:

- Similarity
 - Several ET parts of comparable size have flown with molded ablator
 - Aft Interface Crossbeam
 - LH2/LO2 Cable Tray Gap Closures
 - Aft Interface Press Line Guide Rails
 - GHe Inject Box Enclosure Cover
 - LH2 Umbilical Cable Tray Supports
 - Left/Right SRB Cable Tray Gap Cover
 - GO2/GH2 Press Line Barry Mounts

Class II Process Changes

H35809-973 through -976

Change Description:

- Added 8 hour minimum adhesive cure requirement to drawings where closeouts have greater thickness requirements
 - Previously required 2 hour minimum cure time for these parts
 - Parts include:

LH2/Intertank Flange Closeout	Bipod Ramps
LO2/Intertank Flange Closeout	LH2 Elect. Feedthru
LO2, LH2 & SRB PAL Ramps	Vertical Strut Closeout

Reason for Change:

- The longer cure time prevents foam debond at bond line

Basis for Certification:

- Test
 - Material development test program included extended cure times
- Demonstration
 - Experience showed longer cure time provided better product for thicker closeout
 - Longer cure time has been standard practice
 - Change documents practice in engineering drawings

Class II Process Changes

H35809-985

Change Description:

- For manual foam spray application process on the LO2 Dome, added application of BX-250 per STP1503 as an alternative to application of SS1171 per STP1536

Reason for Change:

- Use of BX-250 reduced non-conformance and rework activities

Basis for Certification:

- Similarity
 - BX-250 application per STP1503 used prior to the implementation of HCFC-141B foams

Class II Process Changes

H36809-202 / STP6514

Change Description:

- Revised Process for wire bonding to LH2 interior to:
 - Reference STP5011 for cleaning wires and STP5013 Method 3 for substrates
 - Remove Freon PCA from list of materials and associated specific cleaning instructions
 - Isopropyl Alcohol (IPA) will be used instead of Freon PCA

Reason for Change:

- Standardization initiative for MAF specifications to call out cleaning per another specification rather than each specification including cleaning instructions
- Removed Freon PCA in an effort to minimize/eliminate use of chemicals that cause ozone depletion

Basis for Certification:

- Test
 - IPA was qualified in test program to be an acceptable replacement for Freon PCA
 - Equivalent removal efficiency of flushing oils, cutting fluids, and tape residue
 - Material compatibility studies identified no issues

Class II Process Changes

H35809-991, H35809-953, H36809-036

Change Description:

- Change weld process from VPPA to TIG on the following assemblies:
 - LO2 Dome Cap
 - LH2 Forward Dome Cap
 - LH2 Barrel Panel Welds on Barrels 2, 3 & 4

Reason for Change:

- Production has experienced better results with TIG than VPPA in the downhand weld orientation used for these welds

Basis for Certification:

- Similarity
 - TIG used on prior LWT builds
- Test
 - Weld certification performed prior to weld on production tooling
 - All Post-DD250 WIC / certification issues for ET-92 have been resolved

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ET-92 Weld Specification Violations

Issue:

- During a recent weld schedule audit, it was determined that several of the ET-92 weld schedules may have been incorrectly certified

Background:

- Certification of a weld schedule requires that the weld pass a series of test requirements
 - Visual appearance
 - NDE
 - Weld microstructure
 - Tensile strength

ET-92 Weld Specification Violations

Discussion:

- Five panels (8" x 24") are welded to certify the weld schedule for each material thickness
 - 2 panels at maximum heat input
 - 1 panel at nominal heat input
 - 2 panels at minimum heat input
- Only the penetration pass amperage is varied to cover the heat input range
- Tests demonstrate a weld parameter range (i.e., volts, amps, travel speed, etc.) from which the weld performs optimally
- On occasion, the weld schedule/equipment requires re-qualification
 - Re-qualification can occur due to weld equipment changes, weld tool changes and failure to successfully weld
- Requirement to re-qualify is to run two weld panels at nominal heat input
- The weld engineer is allowed to adjust only one parameter (other than amperage)
- If more than one parameter is varied or amperage setting is changed, a full re-certification is required (5 panels)

ET-92 Weld Specification Violations

ET-92 Audit Findings:

- Eight tools used to weld ET-92 violated weld certification or weld re-qualification requirements
- Non-conformance documents (NCDs) were written on all findings
- Each discrepancy was assessed by reviewing:
 - Original weld certification documentation and any re-qualification results
 - Printouts of weld parameters used on each weld
 - Weld Instruction Card (WIC) for each weld
- Each NCD was individually dispositioned and approved through various approaches
 - Used other NCDs that had data to cover this issue
 - Ran additional test panels when required
 - Revised the weld certification and/or WIC documentation
 - Duplicated the discrepancy condition and test welded panels
 - Reevaluated margins of safety
- All other ET-92 welds and weld tools were found to be properly certified/re-qualified

ET-92 Weld Specification Violations

Violation Dispositions:

Weld ID	NCD	Parameter Violation	Disposition/Results
HF-G-2 HF-G-8	N034563 (1)	No min./max. panel data for certification of 0.320-0.500-0.220 taper. Parameters were < 5% from nominal setting	Use as is. Schedule will be re-certified prior to future builds using this WIC. Had stability issues welding through tapers; could be negated based on tooling changes which have occurred.
HAG-4 HAG-10	N034563 (2)	No min./max. panel data for certification of 0.320-0.991-0.220 taper. Transition parameters are not documented correctly on WIC	Use as is based on 1999 test panel data. Satisfied certification requirements for gore/gore weld
HF-G-5 HF-G-11	N034563 (3)	No min./max. panel data for certification of 0.320-0.500-0.220 taper. Transition parameters are not documented correctly on WIC	Use as is based on 1999 test panel data. Satisfied certification requirements for gore/gore weld
ODG-5	N034563 (4)	No certification panels available for taper for 5103 "A" side of weld tool	Hardware welded on "B" side of weld tool. No defect
ODG-11	N034563 (5)	Certified schedule with 3 taper panels (nominal and 2 min.). Gore/gore weld certified with 1 panel for 0.320 and 0.360 sections	Use as is based on 1999 test panel data which completed the required number of panels required for certification.
H1-2 H4-7	N034563 (6)	Delta shift taken (ref item 5) with 2 panels 2 years after first production usage	Use as is based on 1999 test panel data which completed the required number of panels required for certification.
HT1-1 HT1-2 HT1-4	N043939	Amps revised from 274-295 to 270-311. Hardware max. amps = 308; max. volts = 41.5; min. amps = 268	Use as is. Parameter violation panels (N034881) used for high end of range. Low end of range is actually of stop top. WIC to have N034881 data attached and picture showing location for proper parameters.
HAF-1	N044801	Amps revised from 98-111 to 98-122. Hardware max amps = 112	Use as is. +1 Amp variance not considered significant
O2 O5	N044855	GDI to Hawcs used 1 nominal O2 and 1 nominal O5 panel to change schedule for O2-O5	Use as is. As-built parameters within previously certified schedule. No hardware defect. Weld schedule will be re-certified
H1-H7	N044973	Major changes (GDI and Hawcs) made with 1 pseudo-panel (not all changes demonstrated). Hardware was outside of last correctly certified schedule	Use as is. Test panel data showed 0.55"-1.000" met STP req't; 0.500" met min. allowable; 0.320" had reduced strength.
ODG	N045354	Travel speed violation where speed was 6 inches/minute and should have been 4.5 inches/minute	Use as is. Data showed reduced design strength. Stress analysis showed MS unaffected.

ET-92 Weld Specification Violations

Rationale for Acceptance:

- All welds have successfully passed proof test
- All welds have passed NDE requirements
- Individual assessments were made of each weld affected by the specification violations
 - Where necessary, welded panels were fabricated and tested to duplicate "as built" parameters
 - Margin of safety statements were prepared for each NCD and weld affected
 - All NCD dispositions were reviewed and approved by MSFC Engineering and S&MA representatives

Corrective actions are underway, including a NASA/LMSS weld audit for compliance with all weld requirements

Agenda

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Prior Mission Performance Summary

Current Mission/External Tank Highlights

ET-92 Mass Properties Status
Changes

Special Topic

- ET-92 Weld Specification Violations

SRM&QA Assessment

KSC Processing

Verification/Certification

Mission Unique Assessment

Readiness Statement

Appendices

- A: Minor Changes
- B: SRM&QA Assessment
- C: KSC Processing
- D: Level II Waivers/Level III Deviations

Lynn Serway

Rick Spring

Don Bolstad

Mike Bankester

Fred Lockhart

Lynn Serway

SRM&QA Assessment

as of 08/27/1999

<u>Item</u>	<u>Status</u>
ALERTS	None Open
MRB Assessment	Complete - No issues/no impact to hazard controls
Hazard Assessment	Complete - All hazard reports were re-assessed and hazard controls verified
Corrective Action Problem Summaries (CAPS)	
<ul style="list-style-type: none">T-067PF, Loss of Intertank SOFI during Ascent of STS-87/ ET-89 (Documents IFA)	Closed pending action
<ul style="list-style-type: none">E-167 ET/SRB Wire Harness Connector Anomaly	Closed Pending Action <ul style="list-style-type: none">ET-92 Successfully Passed Tests

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KSC Processing - Status

as of 08/27/1999

Discrepancy Reports (DRs)/Problem Reports (PRs) Review

- All PR/MRB discrepancies/dispositions similar to previously flown vehicles
- All MRBs have been reviewed by MAF Reliability for potential SMR

Limited Life Component/ET Status

- All within required life through scheduled launch date plus 90 days

OMRSD Exceptions/Waivers: None

KSC Processing - Status

as of 08/27/1999

Changes

- ET modifications
 - Mod Kits 0
 - DC&R 0
 - Bldg 45 2
 - Calibrate 10 AC30 Portable Aircraft Scales
 - FEC 1
 - Thrust panel foam venting
 - OMRSD/LCC 6
 - Intertank Door Closeout (3)
 - LO2 Orbiter/ET Carrier Plate Purge Pressure
 - Tank Pressure Monitoring Requirements (2)
 - Software 0

SIM Launch (S0044) 08/05/99

SIM Load (S0056) 09/28/99

Y2K End to End Test 09/20/99 - 09/22/99

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Verification/Certification
as of 08/27/1999

<u>Item</u>	<u>Status</u>
NSTS 07700, Volume X Baseline	No Issues
<ul style="list-style-type: none">• Revision M, Change 254	
Certification documentation	Complete - No Issues
<ul style="list-style-type: none">• Hardware Certification Sheets (HCS)• Certificates of Qualification (COQ)	

Waivers/Deviations No new items

Mission Unique Assessment

as of 08/27/1999

Category/Item

STS-99

Review of MRB actions using updated loads

ECD 09/06/1999 (UR)

MPS Preflight Prediction Package

ECD 09/06/1999 (UR)

Readiness Statement

**The External Tank, ET-92, is hereby certified
and ready for STS-99 flight pending
completion/closure of open and planned work**

Terry L. Hibbard

Vice President, External Tank Project

Lockheed Martin Michoud Space Systems

Appendices

A: Minor Changes

B: SRM&QA Assessment

- NCD Assessment Criteria

C: KSC Processing

- PR/MRB Summaries
- Modification Summaries/Status
- Limited Life Component Status
- Alternate Blowing Agent Usage at KSC
- Facility Modifications
- Software Changes: None
- OMRSD Exceptions/Waivers: None
- OMRSD Changes (RCNs)

D: Level II Waivers/Level III Deviations

LWT Changes Previously Flown on SLWT

Change No.	Description
B01775D	Revised ET composite nose cone closeout configuration
B02021	Revised ET/SRB alignment control area
B02029	Moved bipod heater functional test to Final Assembly from Bldg. 420
B02031	Eliminated GO2 vent alignment grids
B02050	Modified pressurization line guide rail rub strip installation
B02052	Reduced foam thickness on thrust panel adjacent to ET/SRB fittings
J31186	Implemented producibility enhancements for composite nose cone installation

Minor Changes

<u>Change</u>	<u>Description</u>	<u>Basis for Certification</u>
Deletion of ET Range Safety Systems (B02010)	<ul style="list-style-type: none"> ▪ Added insert to install cable clamp on the Intertank Electrical installation not installed on lower assembly as required ▪ Shortened a screw length to accommodate clamp removal on the pneumatic tube installation by deletion of CDF 	<ul style="list-style-type: none"> ▪ Similarity <ul style="list-style-type: none"> - Insert install to Standard Processes. Standard hardware used. ▪ Engineering Inspection <ul style="list-style-type: none"> - Deletion of RSS bracket called for shorter screw
B02022/J31158	<ul style="list-style-type: none"> ▪ Implement 2219 Class II Extrusions on Frame 1871 	<ul style="list-style-type: none"> ▪ Materials Testing, Stress Analysis, Proof Tests
B02046 (-001,-005,-006)	<ul style="list-style-type: none"> ▪ ET Weighing Requirements changes to support ET weighing capability at MAF 	<ul style="list-style-type: none"> ▪ Similarity <ul style="list-style-type: none"> – Similar weighing system and process used at KSC ▪ Parallel weighing activity in work to verify MAF process

Class II or JS/DCN Changes

- All Class I/II JS/DCN changes have been reviewed by MSFC Resident Office
- All Class II STP/STM/Standards changes have been reviewed by MSFC M&P Lab
- These changes are acceptable for flight and summarized in this appendix (presentation not required)
 - Presentation criteria - Selection for presentation based on changes affecting:
 - Processes
 - Configuration
 - Material
 - Alternate Hardware
 - Presentation rejection criteria - All changes that do not affect configuration, material or processes
 - Revise Point of Incorporation
 - Drawing Clarification
 - Non-Flight Hardware Installation/Removal
 - Datum Changes
 - Update Usage/List of Materials (L/M)
 - Drawing Incorporation Errors
 - Manufacturing Aid
 - Drawing Errors
 - Fastener Type/Grip
 - Tolerance Change
 - Productivity
 - Minor changes taken care of by initial release of Class I Change (Same categories as above)

Minor Class II Changes - Structural

Change No.	Description
H34809-986	Added note on slosh baffle frame fitting to define number in brackets called out on the field of the drawing
H35809-868	Revised 25L13-8 grip length quantities and revised process specification to add STP2006 with note reference. Added rivet code XE = 25L1 and 25L6. Added view to locate XE8N-7 in place of XV8-7 and XE8N-3 in place of XV8-3 on stringer
H35809-878	Gaging per STP2014 added to drawing to reflect build process
H35809-820, 886, 887, 888, 889, 892, 894 & 896	Corrected drawings missing reference to STP2003, countersink and flushness requirements
H36809-024 & 027	
H35809-972	Revised primer application on upper aft ET/SRB fitting to touch up unprimed areas.
H36809-016	Revised cross beam mechanical assembly to allow trimming of gussets to prevent interference
H36809-052	Revised Slosh Baffle Assembly to add note stating tooling holes are optional and may be omitted by manufacturing

Minor Class II Changes - Structural

Change No.	Description
H36809-059	Revised Thermal Isolator Assembly drawing to assure proper application of J536 tape; issued rework DCN to apply tape to side opposite the assembly part number marking
H36809-060	Deleted references to spotface areas on the Intertank to LH2 Splice Installation; there are not spotface areas on drawing
H36809-078	Revise Cable Tray Support Installation to call out correct part number
H36809-084	Revised Cable Tray Cover drawing to include STP1002 and STP2501 requirements that were erroneously omitted from the drawing but correctly reflected in vendor build paper
H36809-086	Revised LO2 Tank Mechanical Assembly & Lug Weld drawing to include graphics inadvertently left out in a previous revision
H36809-092	Revised fastener type in LH2 Barrel #1 Frame Intermediate Frame Installation

Minor Class II Changes – Propulsion/Mechanical

Change No.	Description
H36809-072	Added one fastener to list of materials
H36809-123	Revised Propellant Feed Installation drawing to correct the quantity of bolts called out. MPP reflected correct quantity.
H36809-154, -155	Added alternate rivet for use in Cable Tray Guide Rail Assemblies
J31196-001 through -005	Revised helium inject installation to allow flex hose to meet the minimum bend radius requirement. Shortened tube lengths, created new spacer and revised tube bend data.

Minor Class II Changes - TPS

Change No.	Description
H35809-979	Revised note 4 on LO2 Tank Foam Application drawing to remove the plug pull core height requirement. Core height is specified in Operations Procedure OP-13M50-FT and also accounts for foam rind removal at .75 inch min. thickness where drawing does not.
H35809-982	Delete note in drawing requiring Barry Mount caps as matched pairs after ablator application. MPBs now require match pair traceability prior to ablator application.
H35809-983	Added foam void acceptance criteria to LO2 Feedline support rib locations.
H35809-986	Revised minimum/maximum foam thickness at component build of the flex LO2 feedline to agree with venting inspections done at installation.
H36809-019	Added requirements to control the gap between Composite Nose Cone Seal (MA-25 ablator) and nose cone bulkhead brackets to prevent erosion of NCFI 24-124.
H36809-022	Clarify ablator closeout requirements on LO2 umbilical cable tray TPS application component build to eliminate interference at installation.
H36809-066	Revised LO2 PAL ramp configuration to eliminate less than adequate foam coverage over intertank stringer S7-3. This condition resulted from range safety deletion.
H36809-076	Revised drawing to specify part identification using standard ink stamping instead of marking with stencils; stamping is current standard method used on TPS parts. Also removed dimension associated with deleted top coat application.

Minor Class II Changes - TPS

Change No.	Description
H36809-111	Revised views on Intertank foam application drawing to include local foam trims and dimensions aft of the Intertank GH2 umbilical vent attachments to allow clearance for Launch Pad GSE
H36809-135	Added missing dimensions for foam closeout trims on the LO2 feedline flanges that were inadvertently removed by previous change.
H36809-158	Clarify referenced dimension point of origin on LH2 tank flange at Sta. 1123.15.
H50001-797	Revised crossbeam assembly TPS Application to delete redundant dimensions and added future closeout notation to ablator trim bond lines.
H50001-798	Revised Intertank press line foam aero ramp application to allow aero ramp mold seal PDL to remain on acreage NCFI 24-124 surface; added note that allows for configuration that may vary for LCD foam trim on thrust panel; revised views to adjust nominal foam thickness and minimum foam thickness with actual spray targets used.
H50001-799	Foam migration into adjacent acreage foam rind at Intertank flange foam closeouts; added optional foam closeout at Intertank stringer end; relaxed foam flushness at aero vent tube; accepted localized rind hardness on press line/cable tray bracket closeout.
H50001-800	Relax flushness requirement on LO2 tank plug pulls and to allow foam migration from plug pull repairs to crevices in acreage foam.

Minor Class II Changes - TPS

Change No.	Description
H50001-801	Straightened foam trim lines at bipod fitting and LH2 tank flange closeout and revised dimensions accordingly; opened dimensional tolerances at both LH2 Tank longerons; revised point of origin for longeron foam trim; revised LH2 Tank third hard point trim to allow for foam shadowing; added future foam closeout note to LH2 longeron.
H50001-802	Revised LH2 aft dome cryoflex test panel to waive epoxy primer touch up not required out side test area; removed foam knit line measurements from views not applicable; added future closeout note to foam trim around LH2 feedline penetration.
H50001-805	Added foam migration allowance to aft SRB fittings into the crevices of adjacent acreage foam.

Minor Class II Changes - Electrical

Change No.	Description
H36809-013	Revised clamp sizes to reflect the actual callout on recording table of MPP
H50001-808 & -809	Replaced hard copper conductor wire with soft copper conductor wire for ease for manufacturing

Minor Class II Changes - Systems

Change No.	Description
H36809-075	Revised Load Case H deflections in LH2 Tank Proof test requirements.
H36809-079	Revised weld acceptance manual to add ET allowable structural contour deviations for TPS.
H36809-089	Revised peaking and mismatch of O3, O4, H1 and H8 welds to reflect constraints due to Class I extrusion allowables; revised post-proof inspection requirements.
H36809-090	Revised LH2 Post Proof Test Requirements to, section 3.3 to call out STMY320 for Nitrogen gas used for proof testing; requirements not changed.
H36809-098	Clarified the type of shoe soles allowed Walking Loads Limitations document. Added drawing references, tools and associated graphics. Added note to specify limit on ladder tools.
H36809-220	Revised ET measurement requirements to remove all references specifying how to measure the LH2 and LO2 tanks. Removed tool locations and numbers. Incorporated other minor corrections references.
H36809-262	Revised Acceptance Criteria documents to specify that atmospheric fallout type elements such as SOFII/Ablator dust and foam mist overspray particles produced during VAB acreage spray process are acceptable.

Minor Class II Changes - Systems

Change No.	Description
H36809-238	Revised Loads Data Book to include current database history for LWT/SLWT design and update specific components.
H36809-796	Revised ET Protection Requirements to: identify installation point for GO2 press. line and LO2 feedline fairing; delete protective wrap on bipod fittings and protective tools from nose cone cable tray fairing and louvers; revise GH2 vent line bellows cover to reflect as-built processing
J31176-011 & -017	Clarified ICD requirements on drawings; added reference to ICD 2-00001 on LO2 mechanical assembly and lug weld and LH2 aft dome cap drawings

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
H36809-167	STP6001 Adhesive Bonding	<ul style="list-style-type: none"> - Revised to refer to solvent wiping per STP5002 rather than specifying cleaning instructions within the bonding STP - Updated adhesive name from CREST 7450 to LORD 7450 to reflect vendor name change - <i>No change to processes or chemicals used</i>
H36809-190	1118 - Aluminum Alloy Plate and Sheet	<ul style="list-style-type: none"> - Moved callout for ultrasonic inspection per MIL-STD-2154 Class B for plate exceeding 2000 lbs from drawing to material code sheet - Added clarifying note requiring STM1701 for thickness range of .250 to .499 inch - Added AMS-QQ-A-250/30 as alternate spec for material composition/properties - <i>No change to material used</i>
H36809-243	Y498 – Nitrogen Propellant & Press Agent	Replaced “Helium” inadvertently placed in code title with “Nitrogen”
H36809-261	N308 Drylube Lubricant	Revised code sheet to specify that one can per lot be shipped to MSFC for LO2 Compatibility Testing specimen preparation

Class Changes - STPs/STMs/STDs/AVL

Change No.	Document	Description
B02041A-015	62A1 Stainless Steel Spring Wire	Released material code sheet for Type 302, Class 1 stainless steel spring wire; procurement specification ASTM A313

NCD Assessment Criteria

- Assessment of all MRB Items
 - Adequacy of technical dispositions
 - Completeness of required repair/retest
 - First time occurrences/SMR
 - Verification of margin of safety assessment/documented
 - Review of impact to hazards
 - Engineering review for impact to loads
 - Engineering review for reduced extrusion to plate weld allowables

ET-92 DR/PR/OMRSD Waiver/Exceptions

as of 08/27/1999

System	Discrepancy	Problem	MRB Items	Exceptions/ Waivers
• Electrical	0	0	0	0
• Propulsion/ Pneumatics	0	3	0	0
• Structures	0	2	0	0
• Thermal (TPS)	0	4	1	0
Total	0	9	1	0

ET-92 PR/MRBs, Thermal

<u>PR No./Status</u>	<u>Title/Description</u>	<u>Disposition</u>
PET-92-TS-0004 Item 1	Underfill at +Z end of the -Yaft fairing lower periphery closeout	<ul style="list-style-type: none">• Repair with PDL-1034• Additional bondlines will not affect closeout performance
PET-92-TS-0004 Item 2	Ramp missing from forward periphery closeout	<ul style="list-style-type: none">• Repair with PDL-1034• Additional bondlines will not affect closeout performance

ET-92 KSC Modification Summary/Status

FEC KET-0053

Intertank Thrust Panel Foam Venting

ET-92 Limited Life Components

Cycle Sensitive

<u>Description</u>	<u>Part No.</u>	<u>Serial No.</u>	<u>Limit</u>	<u>Required</u>	<u>Remaining</u>
LH2 Manhole Cover Assy	80914081488 -019	0000737290	100	2	100
LO2 Tank Mechanical Assy	80912002000 -019	0000748780	100	2	100
LH2 Tank Proof Test	80914002000 -019	0000749310	100	2	100
LO2 Manhole Cover Assy	80911001205 -010	0000781680	100	2	100
LO2 Fwd Ogive Cover Plate	80911001207 -029	0000763550	100	2	100
LH2 Manhole Cover Assy -Aft	80911001444 -010	0000727160 0000768950	100	2	100

ET-92 Limited Life Components

Age Sensitive

<u>Description</u>	<u>Part No.</u>	<u>Serial No.</u>	<u>Limit</u>	<u>Initiation</u>	<u>Expiration</u>
External Tank	80901000000	00000085	6 Yrs	4/99	4/2005
	-289				

ET-92 Limited Life Components

Age Sensitive Pyrotechnics - 10 Years Life/Requires Lot Verification Tests After 4 and 7 Years

<u>Description</u>	<u>Part No.</u>	<u>Lot No.</u>	<u>Serial No.</u>	<u>Latest Retest</u>	<u>Expiration</u>
Separator Assy GUCP	PD5000020-059	AAH	0001149	02/24/1998	01/2002
Cartridge Assy	PD5000020-030	AAH	0001304	02/24/1998	01/2002
Cartridge Assy	PD5000020-030	AAH	0001305	02/24/1998	01/2002

ET-92 Alternate Blowing Agent Usage at KSC

<u>Foam</u>	<u>Document</u>	<u>Description</u>	<u>Location</u>	<u>Size</u>
SS-1171	T5141	Aft Hardpoint Closeout	Xt 1973-2076, 180 degrees	4410 sq. in.
PDL-1034	T5249	ET/SRB Aft Fairing Closeout	Xt 2058, 70/290 degrees	240 sq. in.
PDL-1034	T5244	ET/ORB Jack Pad Closeout	Xt 1129, 15/345 degrees	9 sq. in.

STS-99 Facility Modifications

ESR 0.2729 ET/Intertank Heater Installation

- Existing ET intertank heaters were replaced with new Chromalox 100 kw heaters
 - Heater installation and system validation completed

SSP58891 LO2 Pump Controller Replacement

- LO2 pump Robicon variable frequency drive (VFD) controllers were replaced with Allen Bradley VFDs
 - Installation and validation completed 7/2/99

Intertank Door Closeout OMRSD Changes, File IV

Background

- KSC Launch Flow Enhancement team requested Intertank door closeout prior to shipment to KSC
 - Results in flow savings of 5 serial days of ET standalone processing
- MAF engineering revised to closeout Intertank door at MAF for ETs 93-95 and ET-106 and subs (B02049)
 - Several KSC inspections and leak checks would be deleted/revised as result of door closeout
- KSC requested earlier deletion of inspection/leak checks to realize savings beginning with ET-92

Intertank Door Closeout OMRSD Changes, File IV

Description of Change

- Delete ET Intertank inspections and revise leak checks at KSC (KT13565A)
 - Changed inspections (nose cone and Intertank purge tube, electrical cabling, LH2 ullage pressure transducers) and internal GH2 vent valve sense line flow test to contingency to be performed only when Intertank access has been established
 - Replaced leak checks that are performed inside the Intertank (LO2 and LH2 tank pressure ports, GH2 pressurization line, LH2 tank feedthroughs) with leak checks performed external to the Intertank

Rationale for Acceptance

- Similarity - Intertank inspections and leak checks are performed at MAF prior to shipment to KSC
- Approved by Level II PRCBD on 2/11/99 (S053293EJ)

Intertank Door Closeout OMRSD Changes, File IV

Description of Change

- Revise tank pressure monitoring requirement and increase tank pressure lower limit (KT13566M)
 - Extended tank pressure monitoring interval from once per week to within 14 calendar days of last reading as long as pressures are within specification during tank move operations
 - Intertank door closeout eliminates continuous monitoring of tanks during Orbiter mate
 - Increased tank pressure lower limit from 1.7 to 2.2 psig for additional assurance that tank pressure will not decay below minimum requirement

Rationale for Acceptance

- Adequate tank pressure is maintained
 - Historical pressures have not varied +/- 0.5 psig during VAB Integration Cell processing
- Approved by Level II PRCBD on 2/11/99 (S053293EK)

Intertank Door Closeout OMRSD Changes, File IV

Description of Change

- Revise GUCP quick disconnect leak check methods (KT13576M1)
 - Change GUCP 3/8" quick disconnect leak checks to a non-intrusive method using the mass spectrometer at the pad instead of using a flow meter in the VAB
 - GO2/GH2 vent valve, Helium inject, HGDS, Nose cone purge and Intertank purge
 - Acceptable leak rates were adjusted due to the sensitivity of the measuring device

Rationale for Acceptance

- Similarity - Revised leak check methods are adequate to detect leakage at the GUCP quick disconnects
- Approved by Level II PRCBD on 2/11/99 (S053293EM)

LO2 Orbiter/ET Carrier Plate Purge Pressure (KS13664M)

Background

- Purge pressure is required to establish plate gap pressure of 0.25 to 0.7 psig
- Supply pressure for LO2 ET/Orbiter disconnect purge was below OMRSD limit of 375 psig during set-up on STS-95 (ET-98) and STS-96 (ET-100)
 - Waivers approved that accepted lower supply pressure based on analysis that indicated a tight system

Description of Change

- Revise minimum GSE supply pressure for LO2 Orbiter/ET carrier plate purge
 - Was: 375 psig
 - Now: 300 psig

Rationale for Acceptance

- Analysis
 - Lower set point pressure protects for adequate plate gap purge flow
 - Provides for dilution of an aft compartment LCC leak to below 25% O2 concentration with a factor of 4
 - 300 psig provides adequate protection against plate gap
- Approved by Level II PRCBD on 7/16/99 (S053293KW)

Tank Pressure Monitoring Requirements (File IV and II)

MT13625M/MS13626M

Background

- ETs previously shipped to KSC with psig tank pressure monitoring gages installed
 - Calibration inaccuracies in psig gages caused change to psia gages on ETs for shipment to KSC
- After ET offload to the KSC VAB, the ET is monitored by KSC pressure monitoring system using psig gages

Description of Change

- Added tank pressure requirements in psia values for monitoring periods prior to gage installation in the KSC VAB
 - psig
 - Tank pressure requirements 2.2-9.7 **OR** psia 16.9-24.4

Rationale for Acceptance

- Similarity - Positive tank pressure maintained
- Approved by Level II PRCBD on 7/28/99 (S053293HH and S053293HF)

Level II Waivers - Baseline

<u>Document / Requirement</u>	<u>Authority</u>	<u>Paragraph</u>	<u>Waiver No.</u>	<u>Effectivity</u>
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NSTS 07700 Vol V – Information Management Requirements

Generic part name, type, common designation, and part manufacturer H4 code are not required for EEE parts status print out	S00127B 6/28/88	Table C.5 Item 2SR-10	6	ETs 49 & up
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Data required in limited life status report is supplied in acceptance data package	S00127B 6/28/88	Table C.6 Item 2SR-7	8	ETs 49 & up
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Requirement to deliver element pressure vessel historical data to EPO will remain at contractor facility	S00127B 6/28/88	Table C.6 Item 2SR-7	10	ETs 49 & up
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Level II Waivers - Baseline

<u>Document / Requirement</u>	<u>Authority</u>	<u>Paragraph</u>	<u>Waiver No.</u>	<u>Effectivity</u>
NSTS 07700 Vol X – Space Shuttle Flight and Ground System Specification, Book 1 Requirements				
Electrical wiring of redundant systems NSTS 08080-1, 20A/4B	S040732G 6/18/88	Table 2.0	362	ETs 23, 27- 29, 31 & up
Soldering, circuit boards, and connectors	S040732M 9/9/88	3.6.15.1.1	379	ETs 23, 27- 29, 31 & up
PD7400106 circuit boards	S040732M 9/9/88	3.6.15.2.1	382	ETs 23, 27- 29, 31 & up
Pressure transducer circuit boards	S040732M 9/9/88	3.6.15.2.1	383	ETs 23, 27- 29, 31 & up

Level II Waivers - Baseline

<u>Document / Requirement</u>	<u>Authority</u>	<u>Paragraph</u>	<u>Waiver No.</u>	<u>Effectivity</u>
NSTS 07700 Vol X – Space Shuttle Flight and Ground System Specification, Book 1 Requirements				
Debris prevention	S082962A 10/2/98	3.2.1.2.14	675	ETs 92, 97- 105
NSTS 07700-10-MVP-01– Shuttle Master Verification Plan				
Environmental acceptance of ET components	S002130H 3/7/89	3.7.1	13	ETs 23, 27- 29, 31 & up
NSTS 08123 Certification of Flexible Hoses and Bellows				
LH2 feedline bellows	S005203G-R1 8/2/91	1.2	3	ETs 42-45, 47 & up

Level II Waivers - Baseline

<u>Document / Requirement</u>	<u>Authority</u>	<u>Paragraph</u>	<u>Waiver No.</u>	<u>Effectivity</u>
SL-E-0001 – Specification Electromagnetic Compatibility Requirement				
Wire marking is not applicable to the ET	S40732K 9/27/89	3.2.5	3	ETs 23, 27-29, 31 & up
SW-E-0002 – Ground Support Equipment General Design Requirements				
Factor of safety applied to yield for GUCP leg	S87020L 8/17/88	3.4.2.1	21	ETs 23, 27-29, 31 & up

Level III Deviations

<u>Document / Requirement</u>	<u>Paragraph</u>	<u>Waiver No.</u>	<u>Effectivity</u>
CPTO1M09A, External Tank Contract End Item Specification			
<ul style="list-style-type: none">• Photographic evidence shows a loss of foam from both +Y and –Y Intertank Thrust Panels• Analysis concluded a low probability of debris impact on Orbiter critical area	3.2.5	233	ETs 92, 97-99, 101-105




FLIGHT READINESS STATEMENT STS-99/ET-92 EXTERNAL TANK PROJECT DELTA PRE-FLIGHT REVIEW

EXTERNAL TANK ET-92/STS-99, AS IDENTIFIED IN THE EXTERNAL TANK PROJECT DELTA PRE-FLIGHT REVIEW DATED JANUARY 12, 2000, IS CONSIDERED READY TO SUPPORT FLIGHT UPON ACCEPTABLE DISPOSITION OF OPEN/PLANNED WORK AND/OR OPEN ACTIONS.


J. L. LUSK/MP31


A. A. MCCOOL/MP01


J. BULLMAN/ED10


For D. L. DUMBACHER/ED20


For A. F. WHITAKER/ED30

G. R. WALLACE/ED40


For A. O. GOODSON/QS01


P. K. MCCONNAUGHEY/TD01

P. V. COUNTS/MP31, CHAIRMAN

January 12, 2000

**Space Shuttle
External Tank**

**STS-99/ET-92
Delta Pre-Flight
Review**

Agenda

Overview

Prior Mission Performance Summary

Current Mission/External Tank Highlights

Previously Presented Items

- *Intertank Foam IFA: ET-92 Thrust Panel Enhancements*

Lynn Serway

ET-92 Mass Properties Status

Rick Spring

Special Topics

- Certification of ET-92 Weld Specifications

Don Bolstad

- Suspect Weld Rod on ET Hardware

- LO2 Level Sensor Wire Contamination

SRM&QA Assessment

**Greg Daughdrill
Terry McKeough**

KSC Processing

Doug Powell

Verification/Certification

Lynn Serway

Readiness Statement

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Overview

This delta review for STS-99/ET-92 includes any changes/updates to information presented at the Pre-Flight Review on September 1, 1999 :

- Items specific to mission STS-99
- First time changes, differences and “out-of-family” non-conformances not previously flown and/or reviewed

Previously presented items are included in the appendix

Items presented and flown on STS-103/ET-101 are not included

FRR Series

- | | |
|-------------------------------------|------------|
| • ET/SRB Mate Review | 06/28/1999 |
| • Pre-Flight Review | 09/01/1999 |
| • Delta Pre-Flight Review | 01/12/2000 |
| • Space Shuttle Vehicle FRR | 01/18/2000 |
| • Mission Management Team (L-2 Day) | UR |

Prior Mission Performance Summary

STS-103/ET-101 Launch Attempt on 12/17/1999

System

Performance

(Scrub ~ T-9min due to weather)

- | | |
|--------------------|---|
| • OMRSD/LCC | No violations |
| • Instrumentation | Nominal |
| • MPS | Nominal |
| • ET Hazardous Gas | No violations |
| • TPS | All ice/frost observations acceptable per NSTS 08303 <ul style="list-style-type: none">• No ice or frost on acreage areas of tank |

Prior Mission Performance Summary

STS-103/ET-101, 12/19/1999

<u>System</u>	<u>Performance</u>
<ul style="list-style-type: none">• OMRSD/LCC	No violations
<ul style="list-style-type: none">• Instrumentation	<ul style="list-style-type: none">• GH2 ullage pressure #2 and #3 had dropouts during replenish• Performed normally during ascent<ul style="list-style-type: none">• In family with previous flights
<ul style="list-style-type: none">• MPS	Nominal
<ul style="list-style-type: none">• ET Hazardous Gas	No Violations
<ul style="list-style-type: none">• ET Disposal	Nominal
<ul style="list-style-type: none">• TPS	<ul style="list-style-type: none">• All ice/frost observations acceptable per NSTS 08303• No ice or frost on acreage areas of tank

Prior Mission Performance Summary

STS-103/ET-101, 12/19/1999

System

Performance

- Orbiter Tile Damage

Lower surface damage average in size and count average

- Diameter > 1" = 13
- Total = 84

- Post Flight Photo Review

SRB Cameras

- Video review shows a significant decrease in the amount of foam "popcorning" observed on the thrust panels and adjacent stringer panels

Hand Held and Umbilical Cameras

- Film not available for review

Mission/External Tank Highlights

STS-99/ET-92, 01/31/2000 (NET)

Mission

Launch

- Window
- Pad
- Orbiter
- Orbital Inclination
- ET Photo Coverage

STS-99

01/31/2000 (NET)

54 minutes

A

Endeavour (OV-105)

57° - Insertion at 126 NM

- Crew photos from cockpit window
- Umbilical well cameras

Primary Payload

Landing

- Time
- Location

Shuttle Radar Topography Mission (SRTM)

02/11/2000 (NET)

TBD

KSC

External Tank

DD250 Acceptance

Shipped to Launch Site

ET-92

04/19/1999

04/23/1999

Previously Presented Items

The following changes and special topics that are applicable to STS-99/ET-92 and have previously been presented to this board

- Charts presented on these topics are included in Appendix E

Items Presented at STS-99/ET-92 Pre-Flight Review

- Significant Process & Configuration Changes
 - Performance Enhancement (PE) High Q Loads Implementation
 - Implementation of LH2 Common Proof Test
 - LH2 Tank Changes to Accommodate SSME Block II Implementation
 - ***GH2 vent/relief valve with revised acceptance flow on STS-103/ET-101***
 - LH2 Tank Siphon Screen Installation Hardware Changes
 - LWT Intertank Thrust Panel Structural Change
 - Intertank Thrust Panel Foam Venting
 - ***Stringer panel venting will not be performed on ET-92***
 - Class II Process Changes

Items Presented at STS-103/ET-101 Pre-Flight Review

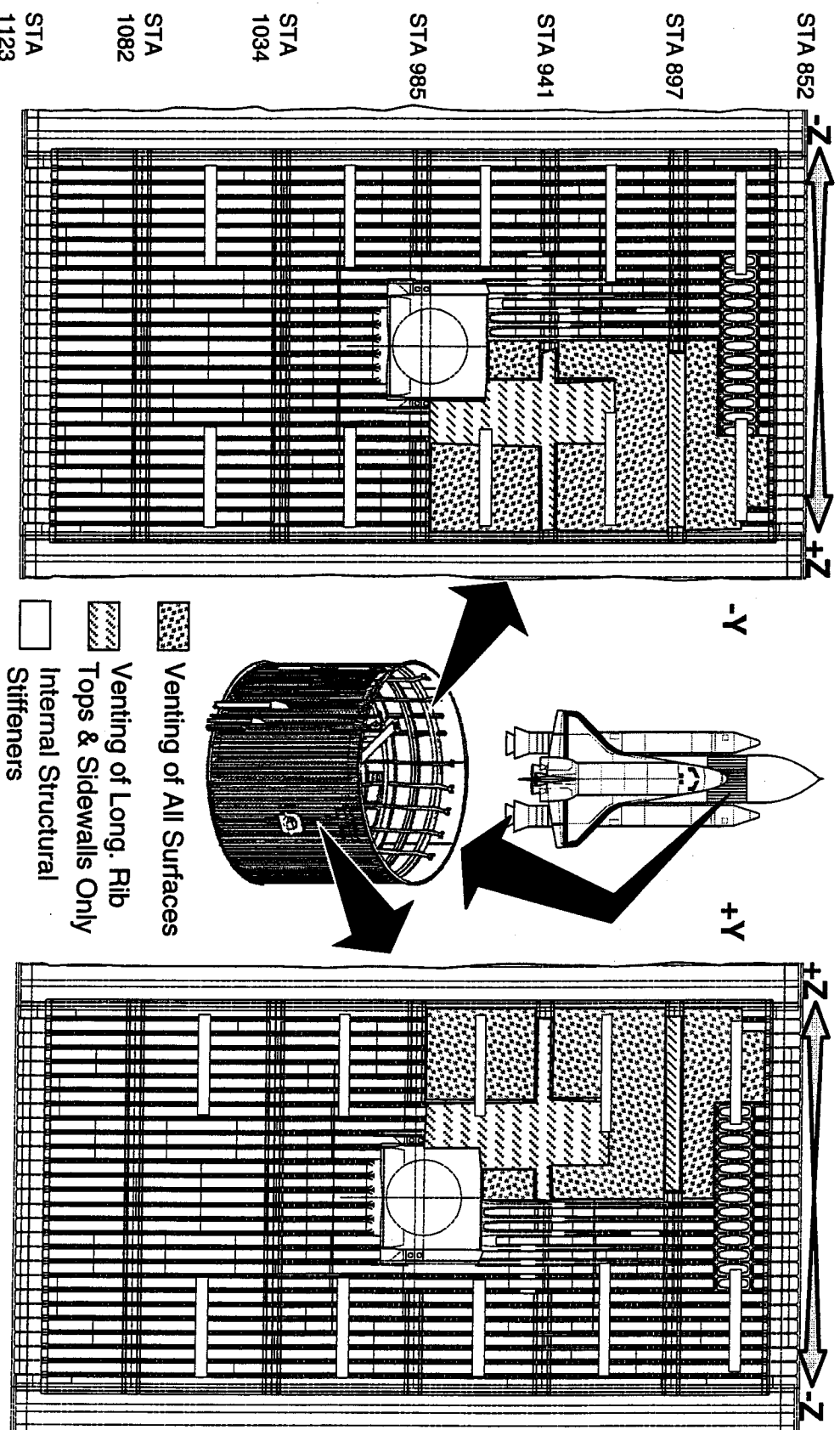
- STS-99/ET-92 Pre-Flight Review Action Item
 - Criteria for Critical Process and Critical Process Change Control

Intertank Foam IFA: ET-92 Thrust Panel Enhancements

Background

- Post flight inspection of STS-87 revealed out-of-family damage to the Orbiter tiles caused by foam loss from the ET Intertank thrust panel
- Intertank thrust panel flexure was initially believed to be a major contributor to foam loss
 - Internal stiffeners added to ET-92 thrust panel to decrease thrust panel flexure
 - SLWT design has external circumferential ribs which reduce thrust panel flexure
- Fault tree analysis and performance of SLWT indicated flexure was not cause of foam loss
 - “Popcorning” identified as mechanism causing foam loss
- A rigorous test program demonstrated that foam venting reduces popcorn-type debris
- Venting of machined foam was certified by test and analysis to do no harm
 - Vented was implemented on STS-96/ET-100 and STS-93/ET-99 thrust panel foam
 - SRB flight video confirmed that performance of foam was enhanced through venting and that popcorning was also exhibited on intertank stringer foam
 - Venting of +Z intertank stringer foam was certified and implemented on STS-103/ET-101
 - Review of SRB flight video showed significant performance enhancement
 - Enhancement confirmed by post landing Orbiter tile damage report
 - 84 total lower surface hits with 13 hits > 1”
- Venting of stringer panel foam will not be performed on ET-92
 - Venting of net spray foam on stringer panels is not certified for flight
- ***ET-92 intertank configuration is not a safety of flight issue***

Intertank Foam IFA: ET-92 Thrust Panel Enhancements



Venting of stringer panel foam will not be performed on ET-92

- *Venting of net spray foam on stringer panels not certified for flight*

Agenda

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Current Mission/External Tank Highlights

Previously Presented Items

- Intertank Foam IFA: ET-92 Thrust Panel Enhancements

ET-92 Mass Properties Status

Special Topics

- Certification of ET-92 Weld Specifications
- Suspect Weld Rod on ET Hardware
- LO2 Level Sensor Wire Contamination

SRM&QA Assessment

KSC Processing

Verification/Certification

Readiness Statement

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Lynn Serway

Rick Spring

Don Bolstad

Greg Daughdrill
Terry McKeough
Doug Powell
Lynn Serway

ET-92 Mass Properties Status

- ET-92 Specification Weight = 69,193 lbs
- ET-92 was weighed 04/28/1999 @ KSC
 - Predicted 65,148 lbs
 - As-weighed 65,292 lbs
 - Delta +144 lbs
- Level II uses “as-weighed” data for mission planning
- ET-92 was weighed with compression platform scales at KSC
 - Suspect PR written on KSC weighing system due to scale platform interference
 - PR (ET-92-ST-0003) closed, disposition invalidates ET-92 actual weight
- LMMSS recommends using predicted weight for mission planning
 - MMC-ET-SE40, ET Project - Mass Properties Weight and Balance Report, has been resubmitted to note that ET-92 as-weighed data is suspect (12/6/99)
- Preliminary coordination with Level II indicates approximately 354 lb performance margin for STS-99

Agenda

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- Intertank Foam IFA: ET-92 Thrust Panel Enhancements

ET-92 Mass Properties Status

Rick Spring

Special Topics

- *Certification of ET-92 Weld Specifications*

Don Bolstad

- *Suspect Weld Rod on ET Hardware*

- LO2 Level Sensor Wire Contamination

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Certification of ET-92 Weld Specifications

Issue

- During a recent weld schedule review, it was determined that several of the weld schedules may have been incorrectly certified

Background

- Weld certification requirements are established through Engineering process requirements documents
 - Certification requirements verify that weld schedules produce acceptable weld strengths and quality
 - Requirements are then restated and implemented in the “how to” manufacturing process documents
- Ambiguity of the weld process documents and reliance on institutional knowledge led to instances of incomplete testing for weld certification

Certification of ET-92 Weld Specifications

Background

- Performed LMSS Quality and Engineering review of all “as-built” ET welds
 - Discrepancies were documented on non-conformance documents (NCDs)
 - Each NCD was individually analyzed, dispositioned and approved by LMSS and NASA/MSFC
 - When necessary, additional welded panels were fabricated and tested
 - All discrepant weld schedules were reviewed to the correct certification condition
 - All NCDs were dispositioned and approved
 - Weld operations were suspended until discrepancies were resolved
- Process escapes led to end-to-end weld process review
 - LMSS and NASA/MSFC conducted a series of reviews (October - present) of all ET welding processes
 - 49 findings require resolution
 - Procedural enhancements
 - Communication/information flow down
 - Adherence to command media
 - Training enhancement opportunities
 - One additional issue identified during NASA/LMSS review
 - Concern for design strength of welds (cryogenic properties) due to effect of weld parameter variations

Certification of ET-92 Weld Specifications

STS-99/ET-92 Rationale for Flight

- Team reviewed the 49 findings noted during the reviews and determined that there were no concerns for ET-92
- Team also conducted an assessment of the weld strength and determined that adequate rationale exists for ET-92 clearance:
 - Weld-by-weld reviews
 - Review of as-built parameter charts
 - ET-92 as-delivered weld tests
 - Parameter range test data (room temperature and cryogenic)
 - History of successful LWT launches
 - Proof test stresses
 - Flight stress analysis
- LMMSS and NASA/MSFC Review Team concluded that there were no safety of flight concerns
 - Cryogenic properties found to be acceptable
 - Resolution of remaining findings are not considered as constraints to flight
 - Root cause identified as lack of clear process requirements and lack of command media that controls weld certifications
 - Corrective action plan is in work

Suspect Weld Rod on ET Hardware

CAPS P-089

Issue

- Incorrect weld rod was used December 1999 in one manual weld in the forward flex section of the GH2 pressurization line during manufacture at AHP (Arrowhead Products)
 - Design of forward GH2 flex section uses 21-6-9 / 21-6-9 with 21-6-9 weld rod
 - Hastelloy-W weld rod used instead of 21-6-9
- STS-99/ET-92 lines fabricated at same supplier

Background

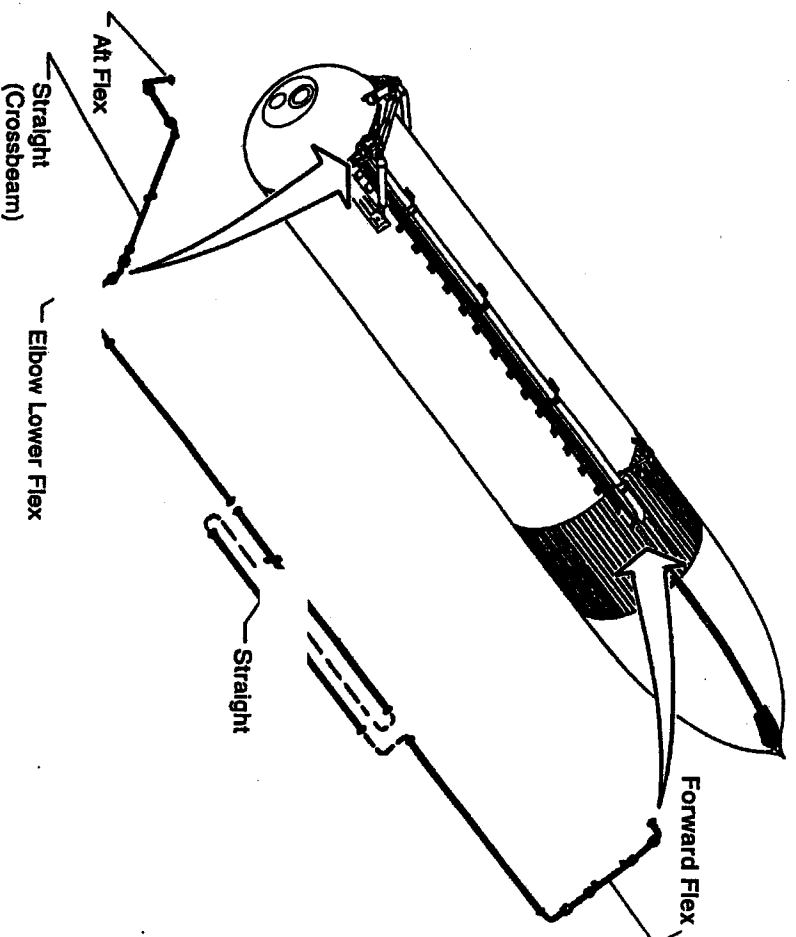
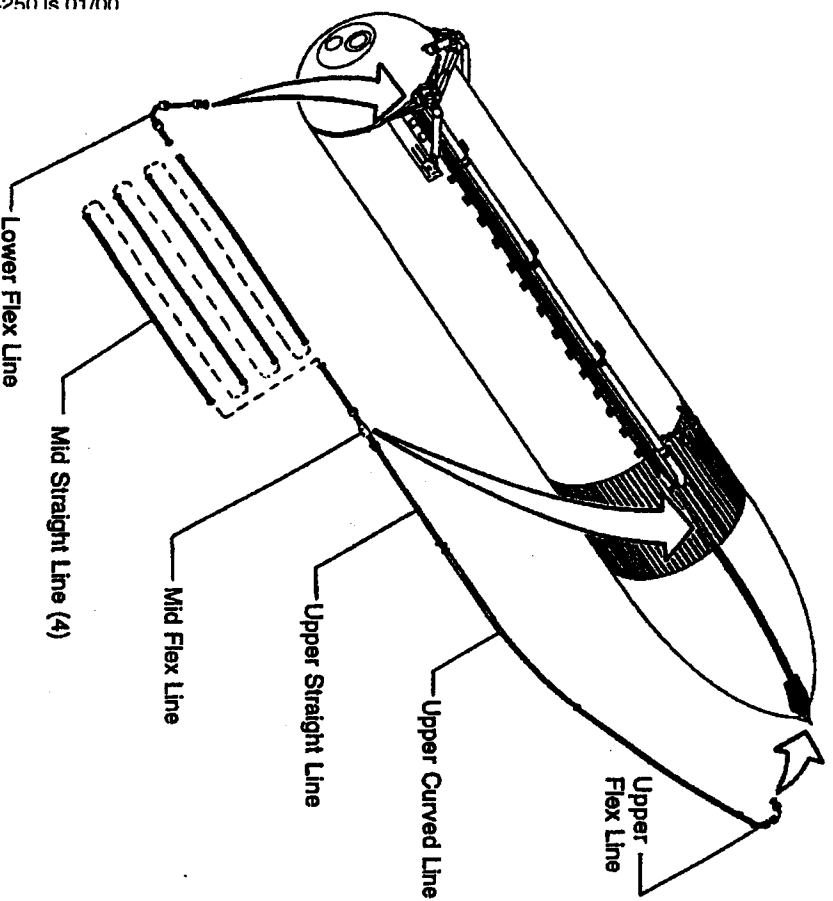
- Discrepancy identified by the AHP x-ray reader during NDE following successful proof test of a forward flex section of the GH2 pressurization line
 - Bimetallic indications were found on the x-ray of a single metal (21-6-9/21-6-9) weld
- Subsequent analysis of the weld bead indicated that the weld rod used was not 21-6-9
 - Independent analysis verified that the weld bead contained Hastelloy-W
- Employee error was determined as cause of incorrect weld rod
 - Welder mixed weld rods during manual weld operation
- All manual welds performed by AHP on ET-92 are suspect
 - Includes most circumferential (line/flange) and fillet (BSTRA) welds
- Automatic welds are not suspect
 - Weld rod alloy verification performed immediately prior to start of each weld and again upon completion

Suspect Weld Rod on ET Hardware

CAPS P-089

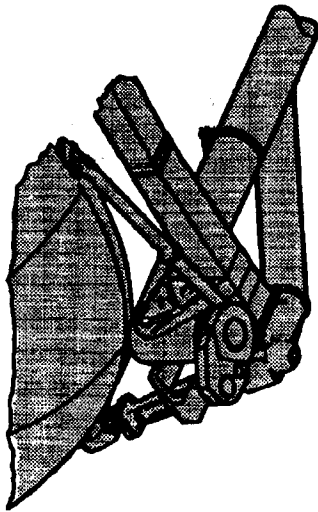
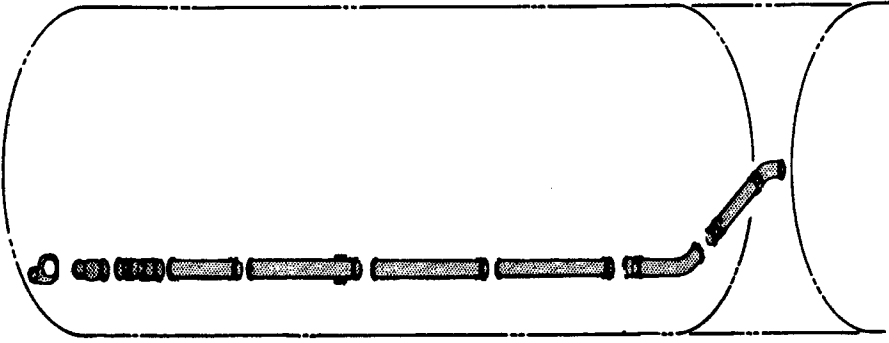
GO2 Pressurization Line Assembly

GH2 Pressurization Line Assembly

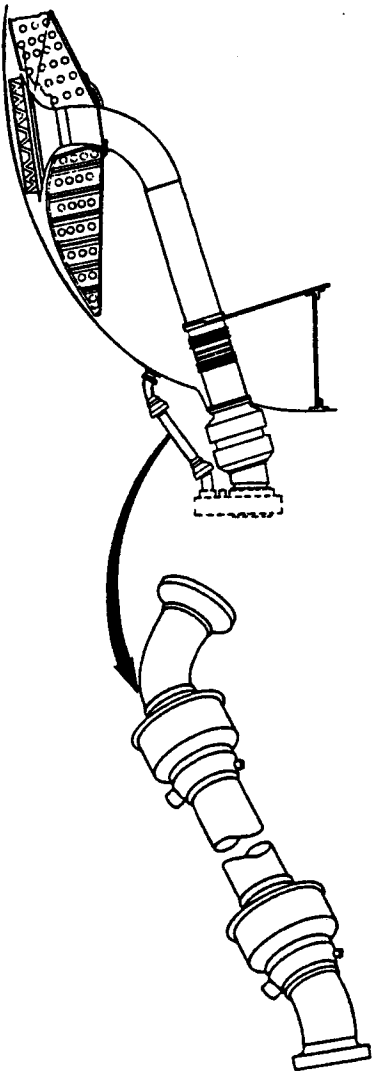


Suspect Weld Rod on ET Hardware CAPS P-089

L02 Feedline Assembly



LH2 Feedline & LH2 Recirculation Line



Suspect Weld Rod on ET Hardware

CAPS P-089

Rationale for Acceptance

- All manual welds, including automated welds with manual repairs, on ET-92 were identified and evaluated for acceptance
- ET-92 single metal weld acceptance based on LMMSS X-ray analysis
 - Incorrect weld rod can be identified on a single alloy x-ray film
 - X-ray analysis cannot be used to identify incorrect material in a bimetallic weld
 - None of the ET-92 single metal weld X-rays exhibited radiographic features indicative of a joint welded incorrect weld rod
 - LMMSS review process and interpretation of radiographs coordinated with AHP, MSFC/NASA S&E, and MSFC/NASA NDE during evaluation of ET-101
- ET-92 bimetallic welds (by design) acceptance based on stress analysis using a “worst case” weld rod
 - AISI 308 determined to be “worst case” weld rod available at AHP
 - All factors of safety are greater than minimum requirement of 1.40
 - Minimum F.S. = 2.35
- Majority of welds proof test demonstrated to greater than 100% of Design Limit Loads

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- Intertank Foam IFA: ET-92 Thrust Panel Enhancements

ET-92 Mass Properties Status

Special Topics

- Certification of ET-92 Weld Specifications
- Suspect Weld Rod on ET Hardware

- ***LO2 Level Sensor Wire Contamination***

SRM&QA Assessment

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LO2 Level Sensor Cable Contamination

NCD N037944/SCAR 99-136

Issue

- Suspected contamination in jacket insulation of cable used in LO2 level sensor circuits

Discussion

- During harness assembly at MAF in November 1999, dark spots noticed between sintered Teflon tapes of jacket insulation on cables used inside of LO2 Tank
 - Laboratory analysis identified the contaminants as oxidized carbon particles with inorganic contribution
- Cable is traceable and is used for the forward and aft liquid level sensor circuits
 - All unflown vehicles have cable installed that is traceable to this lot
 - ET-100 has flown with this lot installed on the forward mast
- NASA/MSFC has issued Problem Advisory
- SCAR (Supplier Corrective Action Request) issued for cause and corrective action

Rationale for Acceptance

- Suspect lot previously passed lot acceptance flammability and LO2 impact tests
- Samples from suspect lot with known contaminants tested for flammability and LO2 impact
 - All samples passed
- There are no technical concerns with the cable

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SRM&QA Assessment

as of 01/11/2000

<u>Item</u>	<u>Status</u>
ALERTS	None
MRB Assessment	Complete - No issues/no impact to hazard controls
Hazard Assessment	Complete - All hazard reports were re-assessed and hazard controls verified
Corrective Action Problem Summaries (CAPS)	Closed pending corrective action
<ul style="list-style-type: none">• T-067PF, Loss of Intertank SOFI during Ascent of STS-87/ ET-89 (Documents IFA)	
<ul style="list-style-type: none">• E-167 ET/SRB Wire Harness Connector Anomaly	Closed
<ul style="list-style-type: none">• E-168, Wire Harness on ET-108 Failed TM04 1500V DWV Test at MAF	ET-92 Cleared - Successfully passed test at MAF
<ul style="list-style-type: none">• P-089, Suspect Weld Rod Used on GH2 Pressurization Line	Discussed as Special Topic

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KSC Processing - Status

as of 01/03/2000

Discrepancy Reports (DRs)/Problem Reports (PRs) Review

- All PR/MRB discrepancies/dispositions similar to previously flown vehicles
- All MRBs have been reviewed by MAF Reliability for potential SMR

Limited Life Component/ET Status

- All within required life through scheduled launch date plus 90 days

OMRSD Exceptions/Waivers: None

Simulations:

- | | |
|-----------------------|-----------------------------------|
| • Launch (S0044) | 08/05/99 (complete) |
| • Load (S0056) | <i>09/28/99 (complete)</i> |
| • Y2K End to End Test | <i>01/13/99 - 01/14/99</i> |